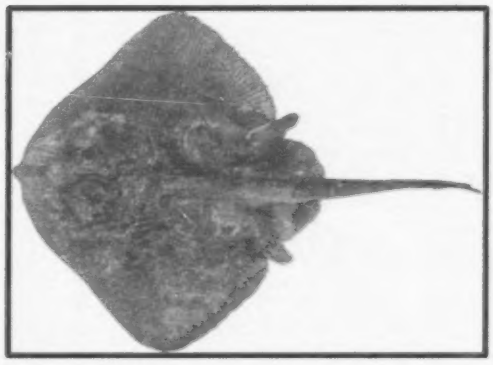
Fisheries and Oceans Canada | Pêches et Océans Canada
Ecosystems and Oceans Science | Sciences des écosystèmes et des océans

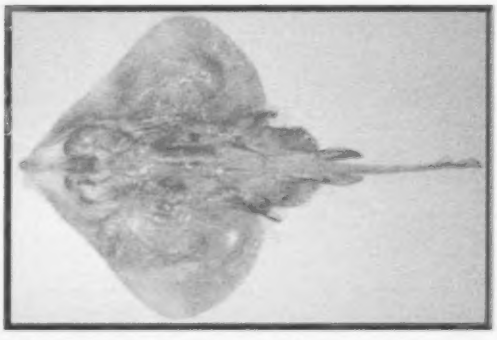
Newfoundland & Labrador, Central & Arctic, Gulf, Maritimes, and Quebec Regions

Canadian Science Advisory Secretariat
Science Response 2017/011

STATUS UPDATES FOR THORNY SKATE IN THE CANADIAN ATLANTIC AND ARCTIC OCEANS AND SMOOTH SKATE (LAURENTIAN-SCOTIAN AND FUNK ISLAND DEEP DESIGNATABLE UNITS)



Thorny Skate (photo: Carolyn Miri, DFO-NL Region)



Smooth Skate (photo: Carolyn Miri, DFO-NL Region)

Figure 1. The Thorny Skate Atlantic/Arctic Oceans DU encompasses all the waters within Canada's Exclusive Economic Zone (EEZ), extending from Baffin Bay south to Georges Bank and including the Gulf of St. Lawrence. The map illustrates the Smooth Skate Funk Island Deep and Laurentian-Scotian Designatable Units (DUs).

March 2017

Canada

Context

In May 2012, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated Thorny Skate (*Amblyraja radiata)* within Canadian waters of the Atlantic and Arctic Oceans as a species of Special Concern, and Smooth Skate (*Malacoraja senta)* in the Funk Island Deep and Laurentian-Scotian Designatable Units (DUs) as Endangered and of Special Concern, respectively (Fig. 1). Canada's *Species at Risk Act* (SARA) species listing process requires listing recommendations to be provided to the Minister of Fisheries and Oceans Canada (DFO) regarding each of these species' DUs. To facilitate this activity, DFO-Science has been requested to update existing annual survey indices for Thorny Skate and Smooth Skate to inform the regional listing advice. This paper provides updated research survey indices for Thorny Skate in the Atlantic and Arctic Oceans, and Smooth Skate in the Funk Island Deep and Laurentian-Scotian DUs, as well as reported fisheries landings and estimated bycatch of each species.

This Science Response Report results from the DFO Science Response Process of 29 November 2016 on the "Status Updates for Thorny Skate (Atlantic/Arctic Designated Unit) and Smooth Skate (Laurentian-Scotian and Funk Island Deep Designatable Units)".

Analysis and Response

The purpose of this report is to provide an update of the major population indices contained in previous assessments of Thorny Skate (Simon 2012; Simpson et al. 2011, 2012*a*; Swain et al. 2012*a*) and Smooth Skate (Simon et al. 2012; Simpson et al. 2012*b*, 2013; Swain et al. 2012*b*). It should be noted that no single research survey provides an index of biomass or abundance for these species in their respective DUs; therefore, various regional survey indices will be used to provide insight into the current status of these species' DUs.

Thorny Skate

Maritimes Region

Updates on the status of Thorny Skate in the DFO Maritimes Region (DFO-MAR) are available in the Maritimes summer Research Vessel (RV) survey and winter RV survey on Georges Bank summary documents (DFO 2016*a*, *b*). DFO has conducted summer research surveys in Northwest Atlantic Fisheries Organization (NAFO) Divisions 4VWX and a small portion of Div. 5Y since 1970, and has conducted winter research surveys in Div. 5Z (Georges Bank) since 1987. In addition to the biomass indices contained in these documents, abundance indices from these surveys are also updated from those contained in previous assessments (Simon et al. 2012; Simpson et al. 2011, 2012*a*; *b*, 2013, Swain et al. 2012*a*, *b*).

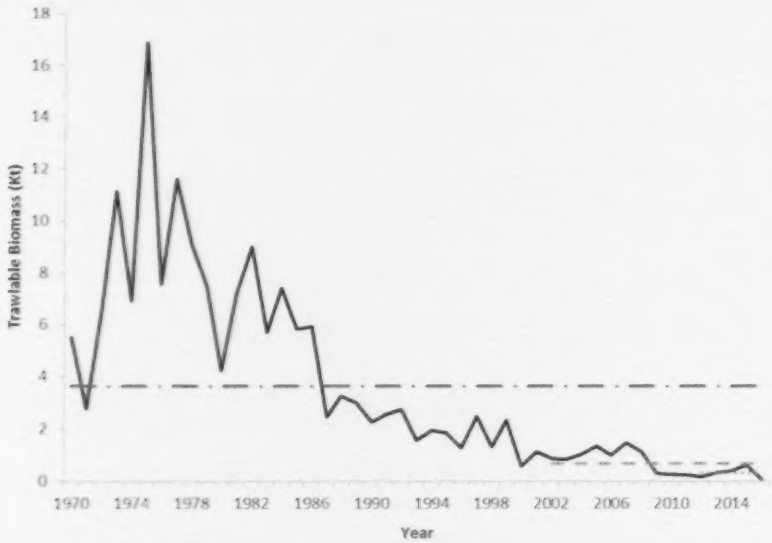


Figure 2. Biomass index for Thorny Skate in Div. 4X from the DFO-MAR summer research survey represented by the solid black line. The straight long dashed-dot line indicates the long-term survey average (1970-2016). The dashed line represents the medium-term 15 year average (2002-16), and the short dotted line represents the short-term 5 year average (2012-16).

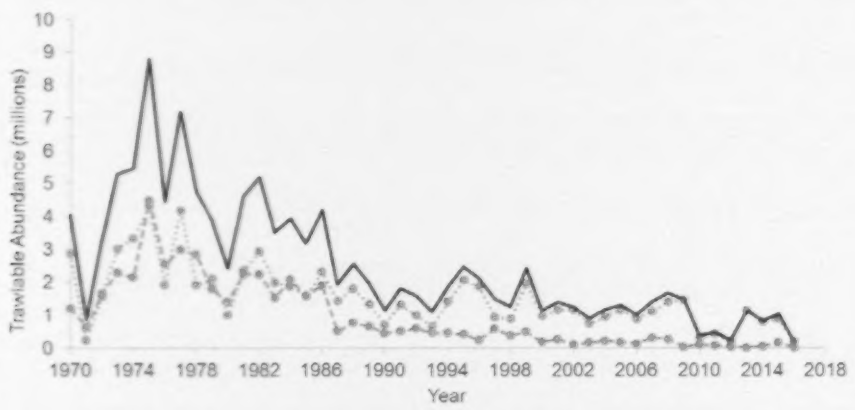


Figure 3. Abundance index for Thorny Skate in Div. 4X from the DFO-MAR summer research survey. The solid black line represents total abundance, while the dotted blue line represents immature (<53 cm TL) skates, and the dashed brown line represents mature (≥53 cm TL) skates.

In the Div. 4X summer survey, the biomass index for Thorny Skate was higher between 1970 and 1985 with a marked decrease up to 2000. It remained well below the long-term average (1970-2014) until 2014 (Fig. 2). In 2014, the biomass index rose slightly above the recent 5-year average (2010-14). A similar trend was observed for the abundance index. Both immature (<53 cm Total Length; TL) and mature (≥53 cm TL) Thorny Skate abundance indices remain very low (Fig. 3). The increase in immature abundance, which was observed over 2013-15, reversed in 2016.

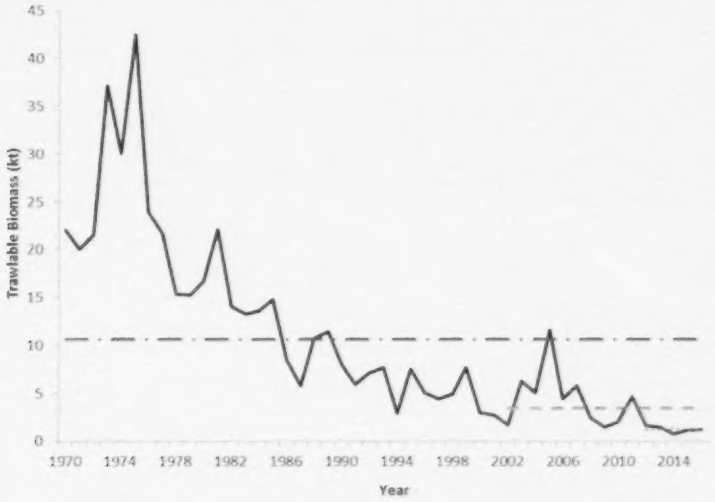


Figure 4. Biomass index for Thorny Skate in Divs. 4VW from the DFO-MAR summer research survey represented by the solid black line. The straight long dashed-dot line indicates the long-term survey average (1970-2016). The dashed line represents the medium-term 15-year average (2002-16), and the short dotted line represents the short-term 5-year average (2012-16).

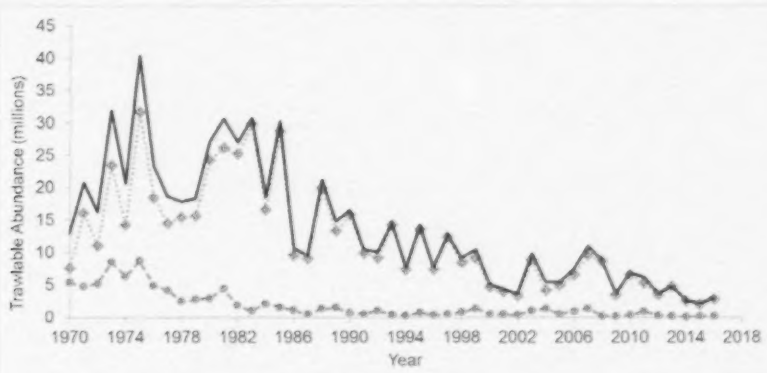


Figure 5. Abundance index for Thorny Skate in Divs. 4VW from the DFO-MAR summer research survey. The solid black line represents total abundance, while the dotted blue line represents immature (<53 cm TL) skates, and the dashed brown line represents mature (≥53 cm TL) skates.

In the DFO-MAR Divs. 4VW summer survey, the biomass of Thorny Skate remains low relative to the long-term average, as well as the biomass estimates of the 1970s and early 1980s (Fig. 4). The biomass estimate for 2014 was the lowest in the time series. Abundance of both immature and mature Thorny Skate remains very low with no overall trend (Fig. 5).

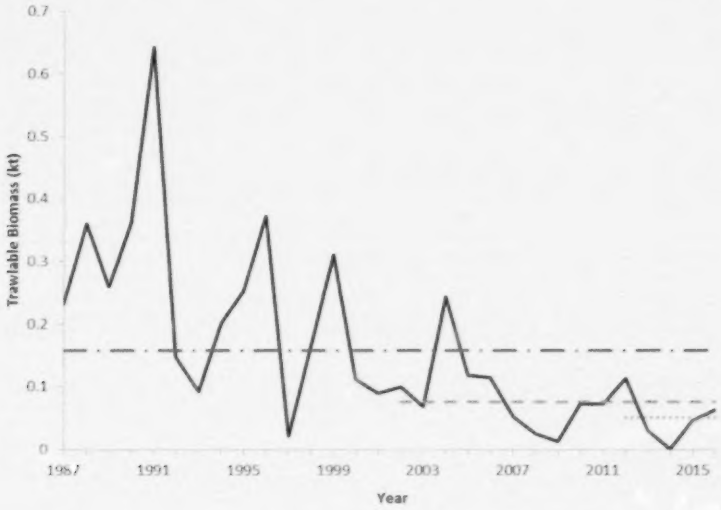


Figure 6. Biomass index for Thorny Skate in strata 5Z1-5Z4 from the DFO-MAR winter research survey is represented by the solid black line. The straight long dashed-dot line indicates the long-term survey average (1987-2016). The dashed line represents the medium-term 15 year average (2002-16), and the short dotted line represents the short-term 5-year average (2012-16).

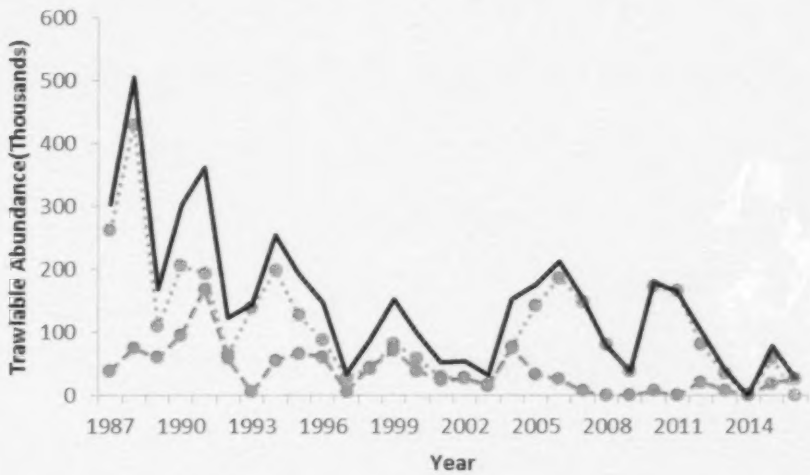


Figure 7. Abundance index for Thorny Skate in Strata 5Z1-5Z4 from the DFO-MAR winter survey. The solid black line represents total abundance, while the dotted blue line represents immature (<53 cm TL) skates, and the dashed brown line represents mature (≥53 cm TL) skates.

In the DFO-MAR Georges Bank winter survey, the biomass of Thorny Skate remains low relative to the long-term average, as well as the biomass estimates of the 1980s (Fig. 6). In the terminal year of the series, the biomass index was slightly above the recent 5-year average.

Overall, the biomass and abundance indices of both immature and mature Thorny Skate (Fig. 7) on Georges Bank and the Scotian Shelf have varied, but remain low relative to the estimates from the 1980s.

Gulf Region

Information on the status of Thorny Skate in the southern Gulf of St. Lawrence is available from the DFO-Gulf Region (DFO-Gulf) annual September research trawl survey in Div. 4T, which commenced in 1971. Research fishing was only conducted during the day until 1985, at which point 24-hour sampling commenced. For Thorny Skate, there is a diel effect in catchability that is also length-dependent, with the effect stronger for smaller fish. There is also a vessel effect, with catchability estimated to be greater for the *E.E. Prince* (1971-84) and *Lady Hammond* (1985-91) than for the CCGS *Alfred Needler* and CCGS *Teleost* (since 1992). Catches have been adjusted for these changes in catchability to produce indices that are consistent over the 1971-2016 time period.

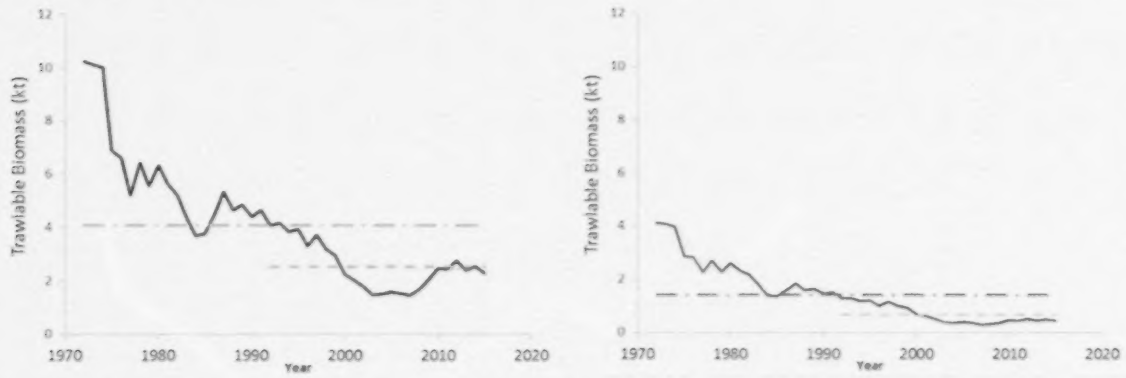


Figure 8. Total biomass indices forThorny Skate from the September DFO-Gulf research survey in the southern Gulf, Div. 4T using night catchabilities (left panel) and daytime catchabilities (right panel). The solid black lines are the 3-year moving average of the biomass indices. The long straight dashed-dot lines are the long-term (1972-2015) averages of the indices, while the dashed lines represent mid-term (1992-2015) averages, and the dotted lines represent the recent 5-year (2011-15) averages.

The total biomass of Thorny Skate in the southern Gulf has declined steadily since the beginning of the time series in 1971, although there is some indication that this decline has ceased in recent years (Fig. 8).

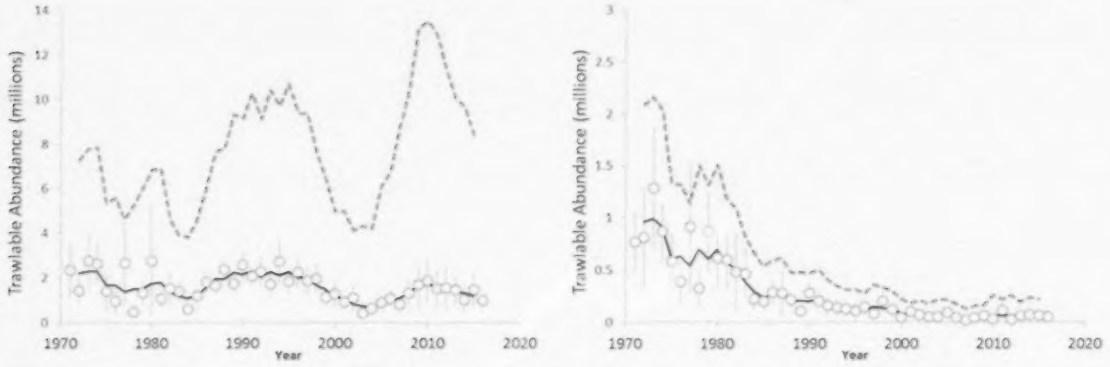


Figure 9. Abundance indices from the September DFO-Gulf research survey of immature (left panel) and mature (right panel) Thorny Skate in the southern Gulf, Div. 4T. The circles with error bars (+/- 2SD) show the daytime catchability index and the heavy black lines are the 3-year moving averages. The dashed lines show the 3-year moving averages for the night catchability index.

Abundance of mature Thorny Skate in the southern Gulf has declined steadily since the early 1980s, though there is some indication that this decline has ceased in recent years. In contrast to the mature abundance, the immature abundance has been variable, and tended to be high in the mid-1990s, as compared to the mid-1970s. This increase was followed by a decline in the early 2000s, which then reversed throughout the later part of the decade. The difference in juvenile abundance trends between day and night reflects the decline in juveniles length composition over time because the diel differences in catchability are greater for smaller fish.

Quebec Region

Updates on the status of Thorny Skate in the Estuary and the northern Gulf of St. Lawrence are available from the DFO-Quebec Region (DFO-Que) annual bottom trawl research survey (Bourdages et al. 2016). Since 1990, DFO-Que has conducted a standardized summer survey in Divs. 4R, 4S, and a portion of Div. 4T* that includes strata of more than 183 m depth and the Estuary. A change in the combination vessel-trawl occurred in 2004 going from the combination CCGS *Needler* vessel – URI trawl to the CCGS *Teleost* - Campelen trawl. Conversion factors for Skate were derived from a comparative fishing experiment performed in 2005 which allows for a continuous survey series starting in 1990 (Bourdages et al. 2007).

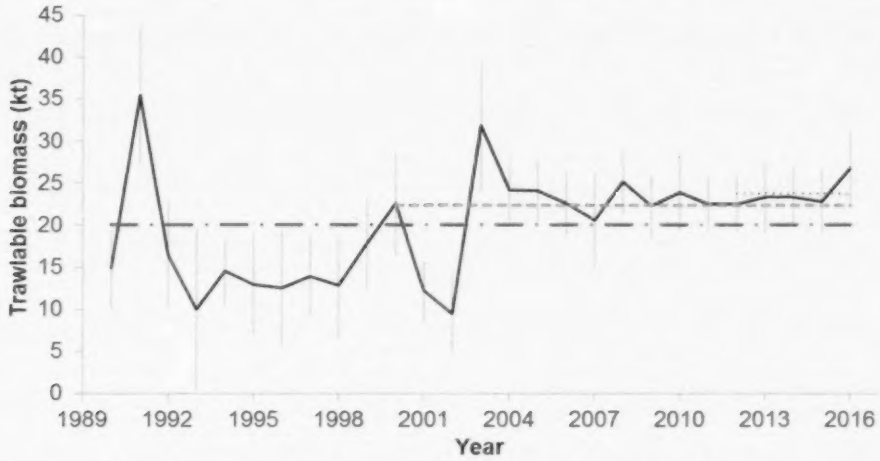


Figure 10. Biomass index for Thorny Skate in Divs. 4RST from the DFO-Que summer research survey represented by the solid black line (vertical lines are 95% CI). The horizontal dashed-dot line represents the long-term survey average (1990-2016), the dashed line the mid-term survey average (2000-16), and the dotted line represents the short-term survey average (2012-16).*

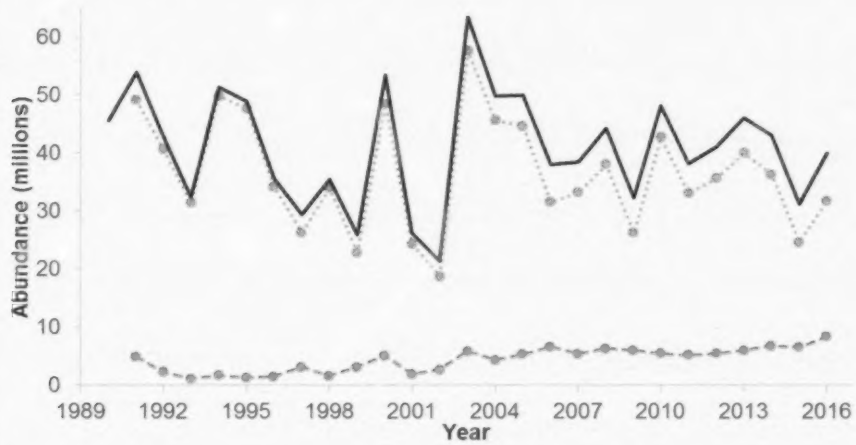


Figure 11. Abundance indices for Thorny Skate in Divs. 4RST from the DFO-Que summer research survey. The solid black line represents total abundance, while the dotted blue line represents immature (<53 cm TL) skates, and the dashed brown line represents mature (≥53 cm TL) skates.*

In the Divs. 4RST* survey, the biomass index of Thorny Skate is lower between 1992 and 2002, and higher between 2004 and 2016. The biomass index has been above the long-term average (1990-2016) since 2003 (Fig. 10), and quite stable since 2004. In this area, the vast majority of Thorny Skates are under 53 cm in size and are considered immature. The abundance of mature Thorny Skate has been stable, or slightly increasing, since 2001. The abundance of immature skates has varied without much trend over the time series (Fig. 11).

Newfoundland and Labrador Region

Updates on the status of Thorny Skate in Newfoundland and Labrador (NL) waters were derived from the DFO-NL Region spring and fall research surveys. DFO-NL has conducted the spring survey in Divs. 3LNO and Subdiv. 3Ps since 1971, and the fall survey in Divs. 2GHJ3KLNO since 1977. During these periods, both surveys have undergone various changes in vessel, gear type, area coverage, and timing (see Simpson et al. 2011, 2012*a*,*b*, 2013). No conversion factor exists for skate; therefore each time series is presented independently.

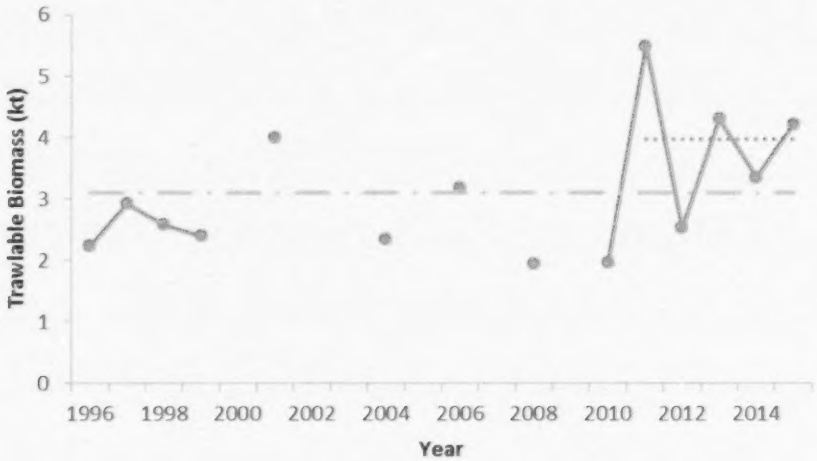


Figure 12. Biomass index for Thorny Skate in Div. 2H from the DFO-NL Region fall Campelen survey (solid blue line). The dashed-dot green line represents the long-term survey average (1996-2015), and the dotted red line represents the short-term survey average (2011-15).

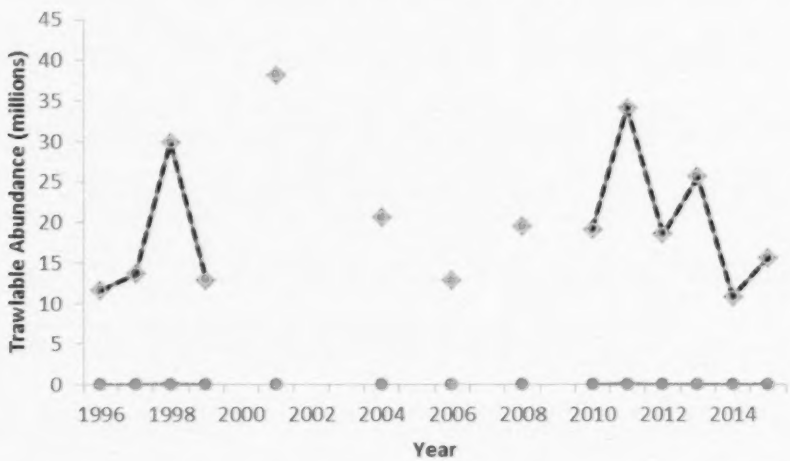


Figure 13. Abundance indices for Thorny Skate in Div. 2H from the DFO-NL Region fall Campelen survey. The solid line represents total abundance, while the dashed line represents immature (<53 cm TL) skates, and the solid line with circles represents mature (≥53 cm TL) skates.

Sampling during the DFO-NL fall survey in Div. 2H has not been consistent throughout 1996-2015, making conclusions on the status of Thorny Skate in this Division problematic. In recent years, the biomass of Thorny Skate has been greater than the 1996-2015 average, but is also highly variable (Fig. 12). Few larger Thorny Skates are captured in this area; therefore, the majority of the population consists of immature (<53 cm) skates (Fig. 13).

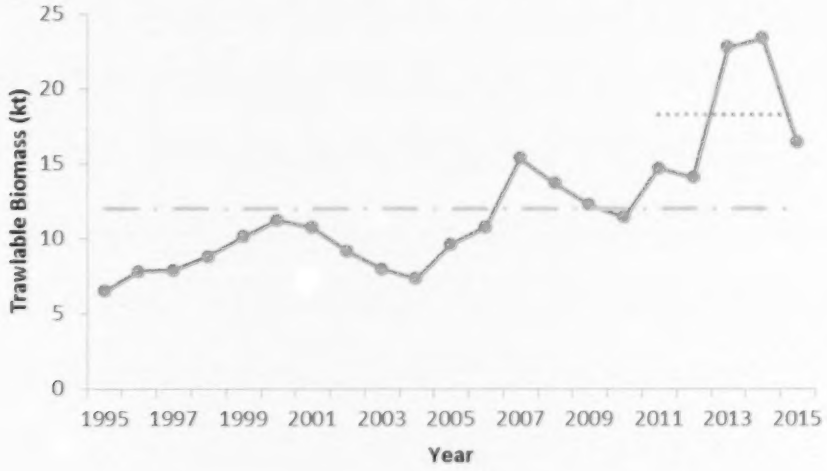


Figure 14. Biomass index for Thorny Skate in Divs. 2J3K from the DFO-NL Region fall Campelen research survey (solid line). The dashed-dot line represents the long-term survey average (1995-2015), and the dotted line represents the short-term survey average (2011-15).

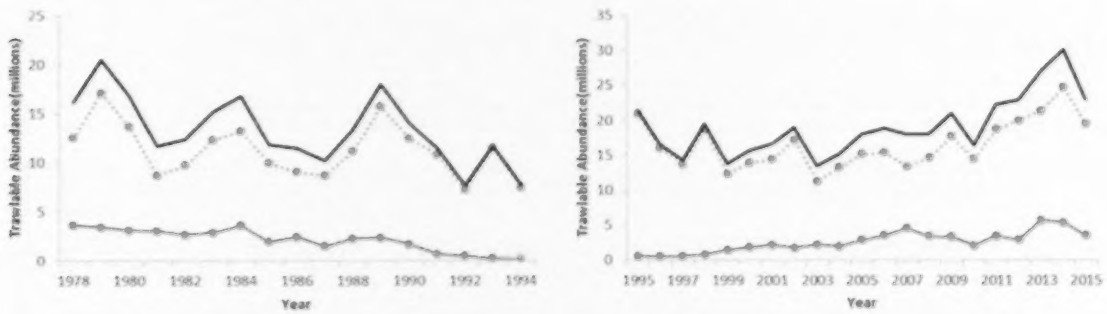


Figure 15. Abundance indices for Thorny Skate in Divs. 2J3K from the DFO-NL Region fall research survey using Engel (left panel) and Campelen (right panel) trawls. The solid back line represents total abundance, while the dashed blue line represents immature (<53 cm TL) skates, and the solid line with circles represents mature (≥53 cm TL) skates.

In Divs. 2J3K, the biomass of Thorny Skate has increased since 2004, with the recent 5-year average being greater than the long-term average of the Campelen 1995-2015 series (Fig. 14). This is reflected in the increased abundance of both immature and mature Thorny Skates (Fig. 15 right panel). In 2015, the index decreased from the peak abundance of 2014.

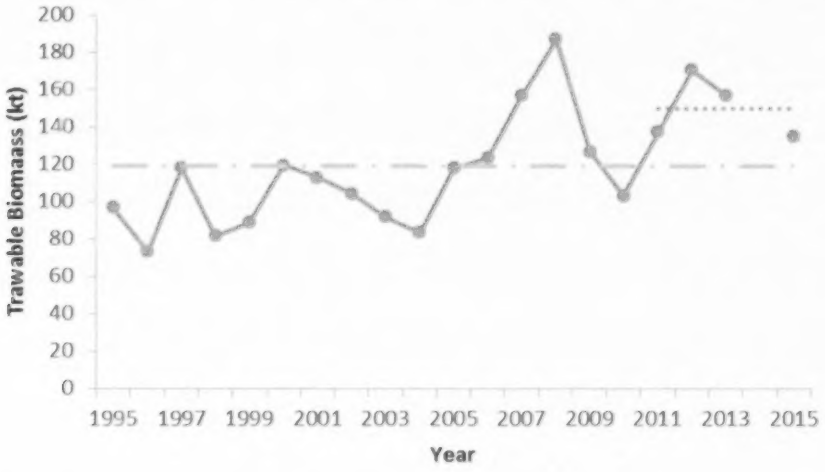


Figure 16. Biomass index for Thorny Skate in Divs. 3LNO from the DFO-NL Region fall Campelen research survey (solid line). The dashed-dot line represents the long-term survey average (1995-2015), and the dotted line represents the short-term survey average (2011-15).

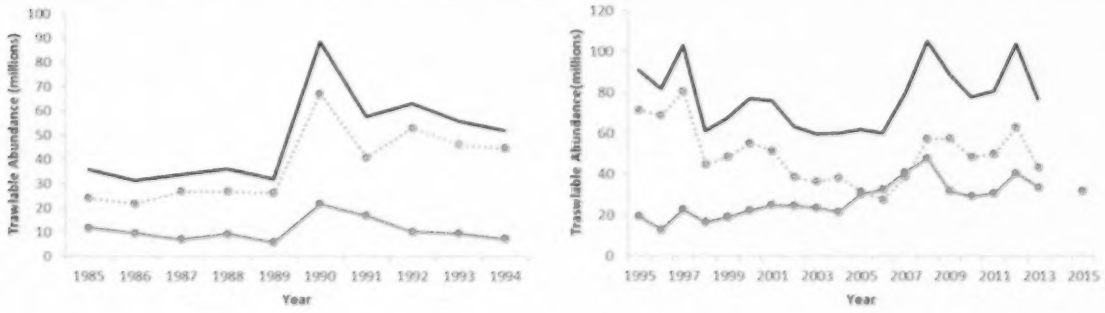


Figure 17. Abundance indices for Thorny Skate in Divs. 3LNO from the DFO-NL Region fall research survey using Engel (left panel) and Campelen (right panel) trawls. The solid black lines represent total abundance, while the dashed blue lines represent immature (<53 cm TL) skates, and the solid lines with circles represent mature (≥53 cm TL) skates.

In Divs. 3LNO, the fall survey biomass of Thorny Skate has been variable but generally increasing since 2004, with the recent 5-year average being above the long-term average of the 1995-2015 series (Fig. 16). This is reflected in the increased abundance of mature Thorny Skates (Fig. 17 right panel). In 2015, the total abundance index decreased relative to the peak observed in 2012.

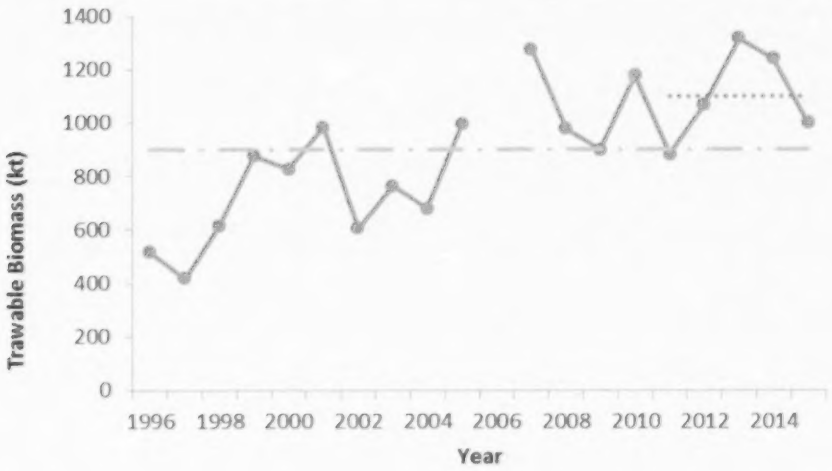


Figure 18. Biomass index for Thorny Skate in Divs. 3LNO from the DFO-NL Region spring Campelen research survey (solid line). The dashed-dot line represents the long-term survey average (1996-2015), and the dotted line represents the short-term survey average (2011-15).

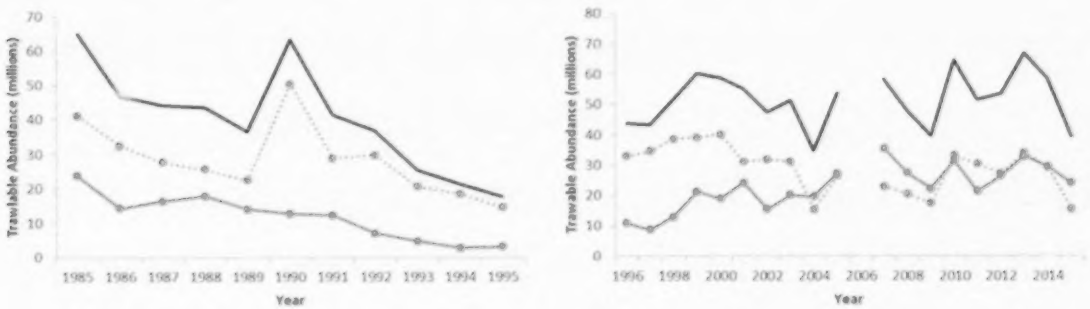


Figure 19. Abundance indices for Thorny Skate in Divs. 3LNO from the DFO-NL Region spring research survey using Engel (left panel) and Campelen(right panel) trawls. The solid black lines represent total abundance, while the dashed blue lines represent immature (<53 cm TL) skates, and the solid lines with circles represent mature (≥53 cm TL) skates.

In Divs. 3LNO, the spring survey biomass of Thorny Skate has been variable but generally increasing since 1997, with the recent 5-year average being greater than the long-term average of this series (Fig. 18). This is evident in the slow increase in abundance of mature Thorny Skates (Fig. 19, right panel).

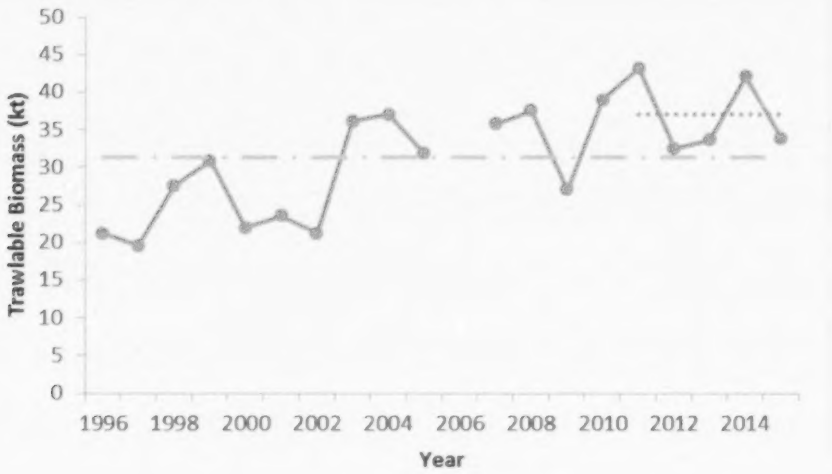


Figure 20. Biomass index for Thorny Skate in Subdiv. 3Ps from the DFO-NL Region spring Campelen research survey (solid line). The dashed-dot line represents the long-term survey average (1996-2015), and the dotted line represents the short-term survey average (2011-15).

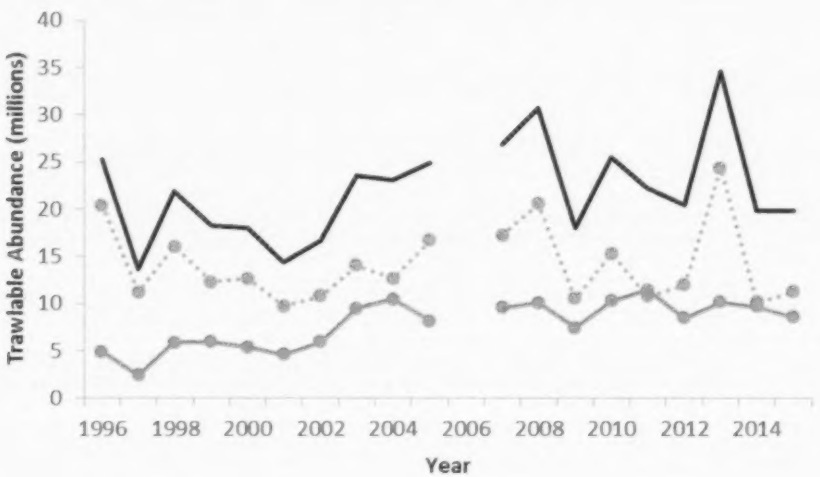


Figure 21. Abundance indices for Thorny Skate in Subdiv. 3Ps from the DFO-NL Region spring Campelen survey. The solid black line represents total abundance, while the dashed blue line represents immature (<53 cm TL) skates, and the solid brown line with circles represents mature (≥53 cm TL) skates.

In Subdiv. 3Ps, the spring survey biomass of Thorny Skate has been variable but generally increasing since 2002, with the recent 5-year average being greater than the long-term average of this series (Fig. 20). There has been a gradual increase in the abundance of mature Thorny Skates from 1997 to 2015 (Fig. 21).

Central & Arctic Region

Data to update the status of Thorny Skate in Central and Arctic Region (DFO-C&A) waters are available from the DFO-C&A deep-water bottom trawl research surveys conducted since 1999 in Baffin Bay, Davis Strait, and Hudson Strait. Southern Div. 0A (Baffin Bay to approximately 72°N) has been surveyed most frequently (1999, 2001, every second year in 2004-12, and annually since 2014; Treble 2016). Northern Div. 0A (73°N-75.5°N) was surveyed in 2004, 2010, and 2012 (Treble 2013). Inshore areas along the Baffin coast were covered in 2006 and 2008, and Hudson Strait-Ungava Bay was surveyed every second year in 2007-13. Div. 0B was surveyed in 2000, 2001, 2011, and 2013-15 (Treble 2016). Survey catch weights and numbers have been relatively low in Subarea (SA) 0 and Shrimp Fishing Areas (SFAs) 2 and 3 when compared to survey catches further south on the Labrador Shelf and Grand Banks. When they were encountered, total weights and numbers of Thorny Skate ranged between 0.005 kg-105.2 kg and 1-472 fish per set, respectively. The majority of Thorny Skate observed in the C&A surveys are juveniles, measuring less than 53 cm TL. Individual measurements have been recorded for 4,018 Thorny Skate caught between 2004 and 2015; 3,998 individuals were immature and 20 were mature.

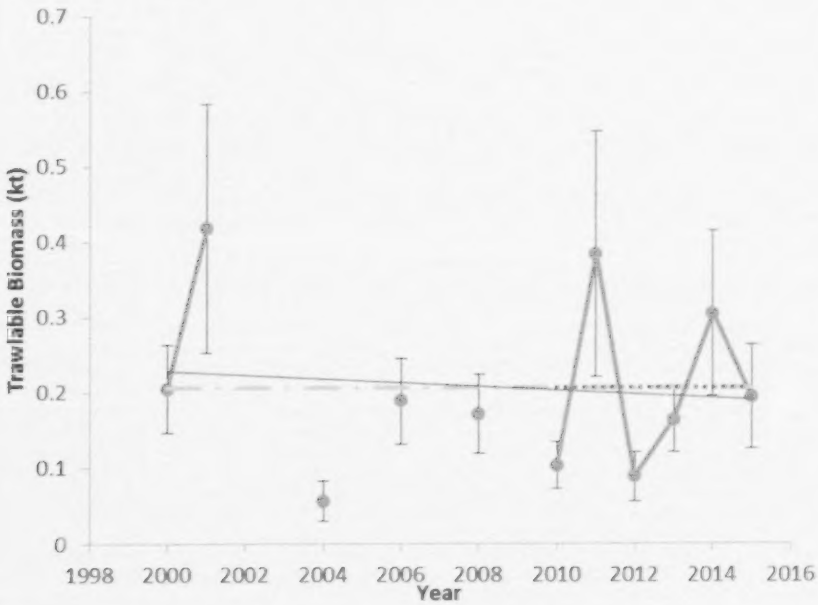


Figure 22. Biomass index for Thorny Skate in SA 0 from the DFO-C&A deep-water bottom trawl research survey (solid line; vertical bars indicate 1 standard error). The dashed-dot line represents the long-term survey average (2000-15), and the dotted line represents the short-term survey average (2010-15).

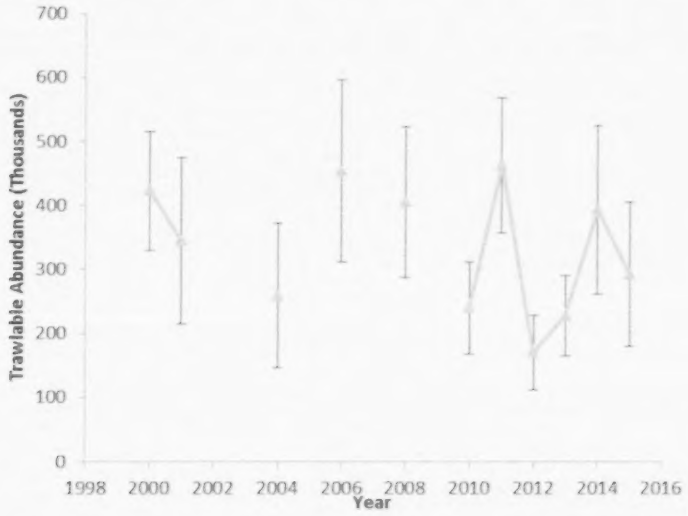


Figure 23. Abundance index for Thorny Skate in SA 0 from the DFO-C&A deep-water bottom trawl research survey. Catches of mature Thorny Skate (≥53 cm TL) are very rare in C&A surveys (20 out of 4,018 individuals measured over 11 years); consequently, the total biomass index is equivalent to an immature biomass index. The vertical bars indicate 1 standard error.

The biomass index for Thorny Skate in SA 0 has fluctuated between 56 and 383 t (Fig. 22). Prior to 2014, index values tended to be lower in even years when the survey area focused on Div. 0A, compared to odd years when the survey occurred further south and covered the southern portion of Div. 0A and portions of Div. 0B. The two index values generated since the survey area was consolidated in 2014 are insufficient to ascertain any pattern or trend. There is little difference between the long-term (2000-15, 206.88 t) and short-term (2010-15, 206.23 t) averages for the biomass index. The total abundance index has varied through time but without any statistically significant trend (Fig. 23).

Smooth Skate - Laurentian-Scotian DU

Maritimes Region

Updates on the status of Smooth Skate in Maritimes Region waters are available in the DFO-MAR research survey summary documents (DFO 2016*a*, DFO 2016*b*). DFO has conducted summer surveys in Divs. 4VWX and a small portion of Div. 5Y, using a standardized protocol since 1970, and winter surveys in Div. 5Z (Georges Bank) since 1987.

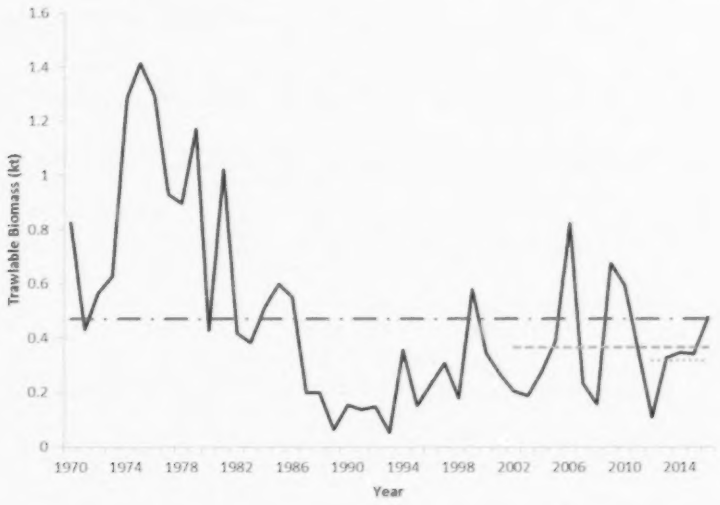


Figure 24. Biomass index for Smooth Skate in Div. 4X from the DFO-MAR summer research survey is represented by the solid black line. The dashed-dot line indicates the long-term survey average (1970-2016). The dashed line represents the medium-term 15-year average (2002-16), and the dotted line represents the short-term 5-year average (2012-16).

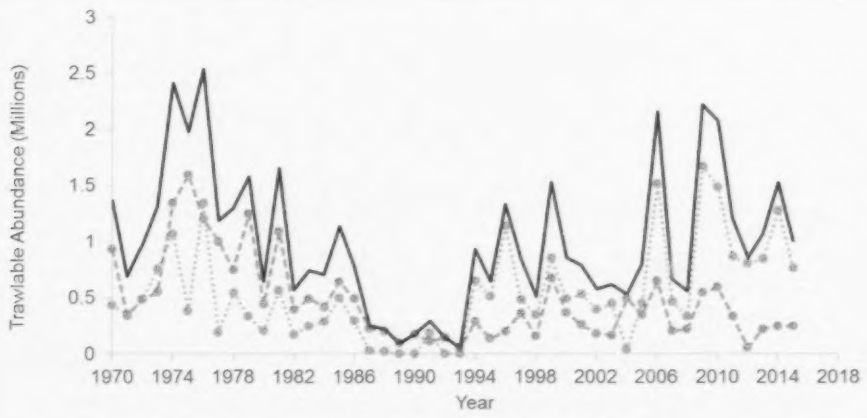


Figure 25. Abundance indices for Smooth Skate in Div. 4X from the DFO-MAR summer research survey. The solid black line represents total abundance, while the dotted blue line represents immature (<48 cm TL) skates and the dashed brown line represents mature (≥48 cm TL) skates.

In the DFO-MAR Div. 4X summer survey, the biomass of Smooth Skate has recently returned to a level comparable to the long-term average, but remains below the biomass estimates from the mid-1970s (Fig. 24). In the mid-term, this biomass index has been quite variable. In recent years, the biomass index has been above the recent 5-year and 15-year averages. Abundance of both immature and mature Smooth Skate has also been variable (Fig. 25). The abundance of mature Smooth Skate in 2013-15 increased from the series low in 2012.

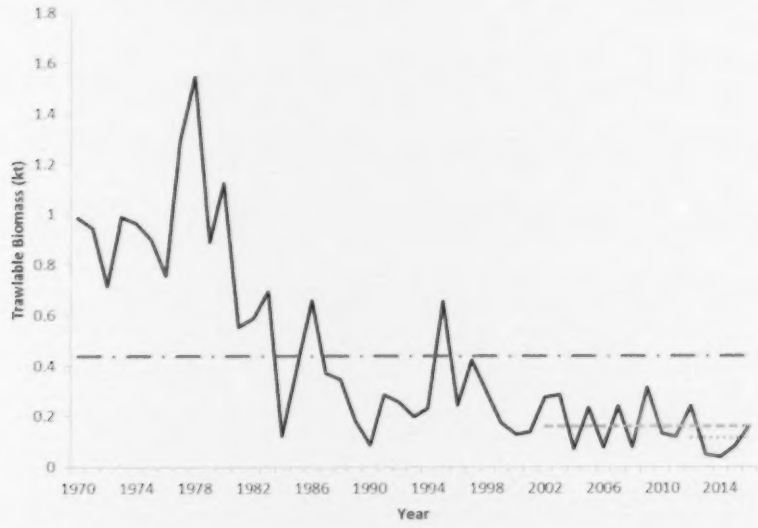


Figure 26. Biomass index for Smooth Skate in Divs. 4VW from the DFO-MAR summer research survey represented by the solid black line. The dashed-dot line indicates the long-term survey average (1970-2016). The dashed line represents the medium-term 15-year average (2002-16), and the dotted line represents the short-term 5-year average (2012-16).

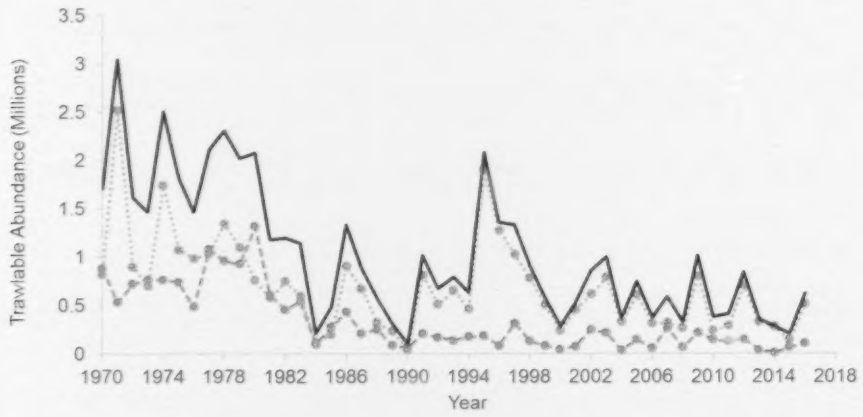


Figure 27. Abundance indices for Smooth Skate in Divs. 4VW from the DFO-MAR summer research survey. The solid black line represents total abundance, while the dotted blue line represents immature (<48 cm TL) skates and the dashed brown line represents mature (≥48 cm TL) skates.

In the DFO-MAR Divs. 4VW survey, the biomass of Smooth Skate remains low relative to the long term average, as well as the biomass estimates of the 1970s and early 1980s (Fig. 26). In the short-term, this biomass index has moved above the recent 5-year average in the terminal year of the series and has reached a level comparable to the recent 15-year average. Abundance of both immature and mature Smooth Skate has also been variable, but generally declining, since 1995 (Fig. 27). The abundance of both immature and mature Smooth Skate in 2016 increased from the low values in 2014 (for matures) and 2015 (for immatures).

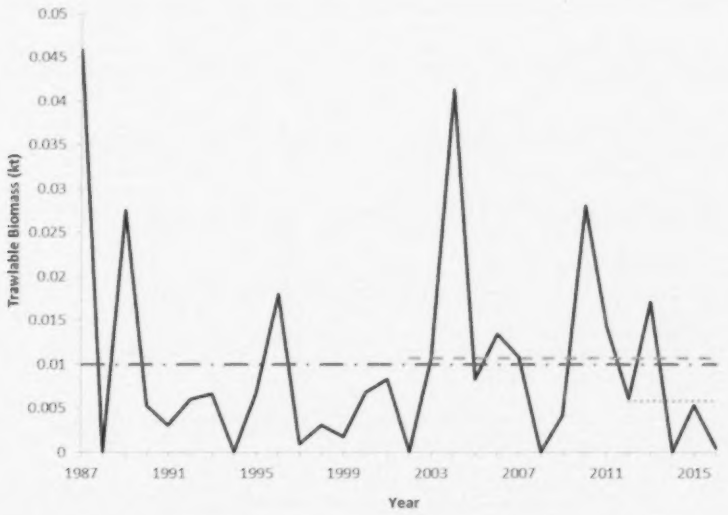


Figure 28. Biomass index for Smooth Skate in strata 5Z1-5Z4 from the DFO-MAR winter research survey is represented by the solid black line. The dashed-dot line indicates the long-term survey average (1987-2016). The dashed line represents the medium-term 15-year average (2002-16), and the dotted line represents the short-term 5-year average (2012-16).

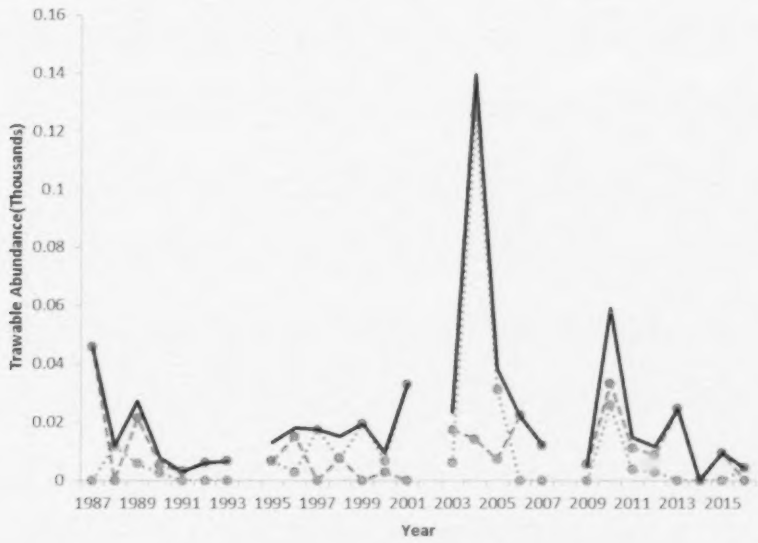


Figure 29. Abundance indices for Smooth Skate in Strata 5Z1-5Z4 from the DFO-MAR winter survey. The solid black line represents total abundance, while the dashed blue line represents immature (<48 cm TL) skates and the dashed line with circles represents mature (≥48 cm TL) skates.

In the DFO-MAR Div. 5Z survey, the biomass of Smooth Skate has been variable throughout the time series, and remains low relative to both the short-term and long-term averages (Fig. 28). Abundance of both immature and mature Smooth Skate has also been variable, but generally declining since the peak abundance of 2004 (Fig. 29).

Gulf Region

Information on the status of Smooth Skate in the southern Gulf of St. Lawrence is available from the DFO-Gulf annual September research trawl survey in Div. 4T, which commenced in 1971. Fishing was only conducted during the day until 1985, at which point 24-hour sampling commenced. Unlike Thorny Skate, the diel effects were not length-dependent for Smooth Skate. Thus, the trends for Smooth Skate are similar for both day and night indices, with the small differences reflecting changes in the proportion of skate catches that occurred in day or night.

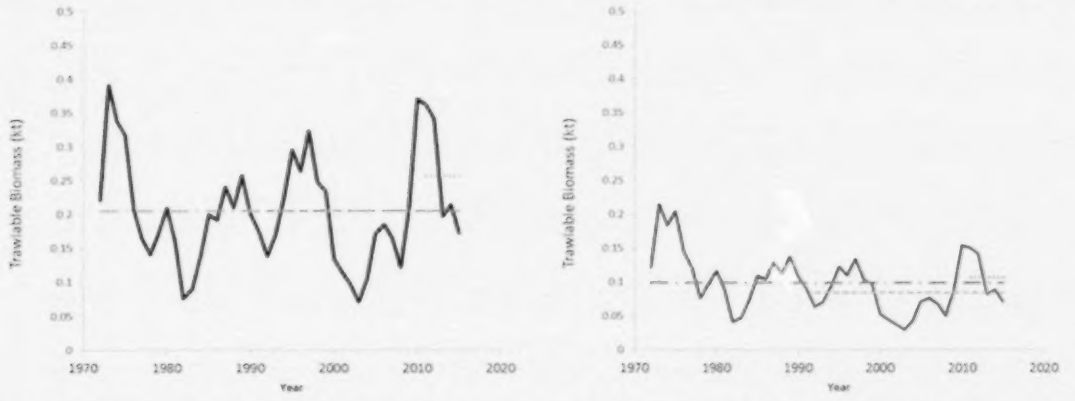


Figure 30. Indices of total Smooth Skate biomass from the DFO-Gulf September research survey in the southern Gulf, Div. 4T using night catchabilities (left panel) and daytime catchabilities (right panel). The solid black lines are the 3-year moving averages of the biomass indices. The dashed-dot lines are the long-term (1972-2015) averages of the indices, while the dashed lines are the medium term (1992-2015) averages and the dotted lines represent the recent 5-year (2011-15) averages.

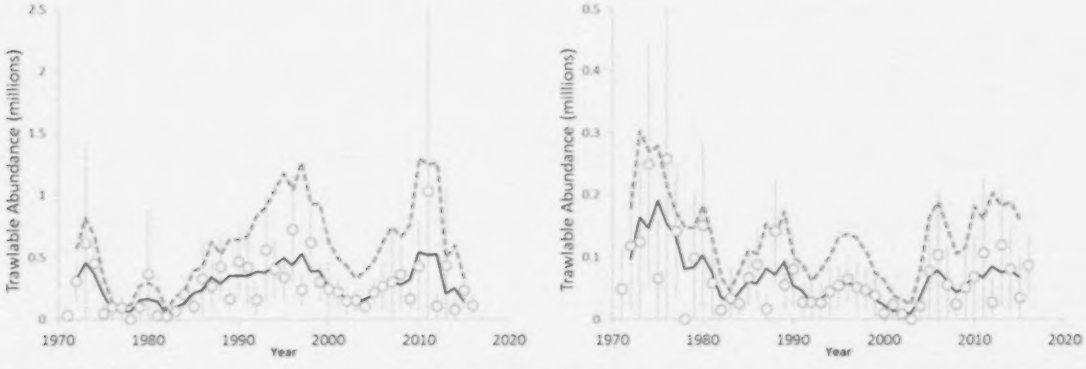


Figure 31. Abundance indices from the DFO-Gulf September survey of immature (left panel) and adult (right panel) Smooth Skate in the southern Gulf, Div. 4T. The circles with error bars (+/- 2SD) show the day catchability indices, and the solid black lines are the 3-year moving averages. The dashed red lines show the 3-year moving averages for the night catchability indices.

Total biomass of Smooth Skate in the southern Gulf has been variable since the beginning of the time series in 1971 (Fig. 30). Current biomass estimates are near the long-term average, but below the short-term average. Similarly, the abundance of adult and juvenile Smooth Skate in the southern Gulf has been variable (Fig. 31); the abundance of adults increased in the mid-2000s, but has since been relatively stable.

Quebec Region

Updates on the status of Smooth Skate in the Estuary and the northern Gulf of St. Lawrence are available from the DFO-Que annual bottom trawl research survey (Bourdages et al. 2016). Since 1990, DFO-Que has conducted a standardized summer survey in Div. 4R, 4S, and a portion of Div. 4T that includes the Estuary and waters of more than 200 m depth.

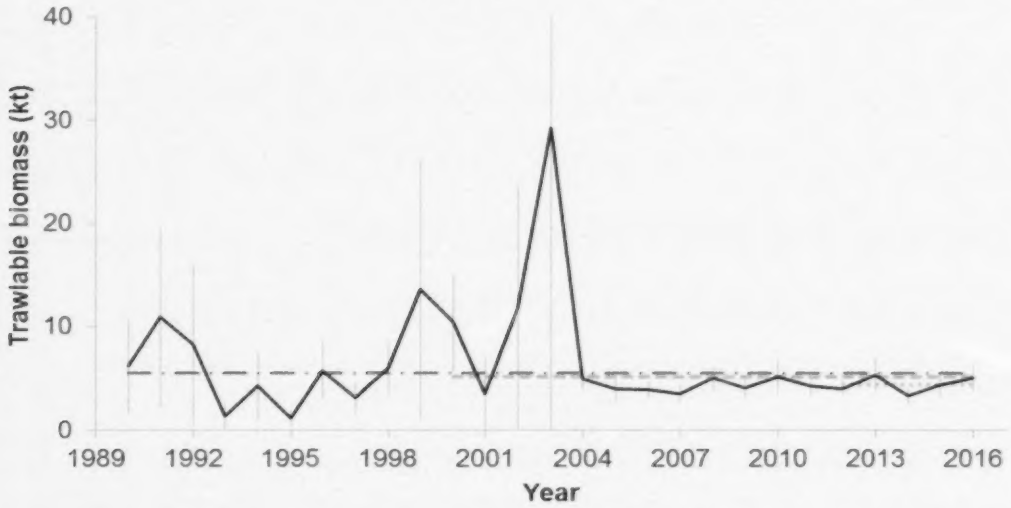


Figure 32. Biomass index for Smooth Skate in Divs. 4RST from the DFO-Que summer research survey represented by the solid black line (vertical grey lines are 95% CI). The horizontal dashed-dot line represents the long-term survey average (1990-2016), the dashed line the mid-term survey average (2000-16), and the dotted line represents the short-term survey average (2012-16). Averages were calculated excluding the 2003 outlier year.*

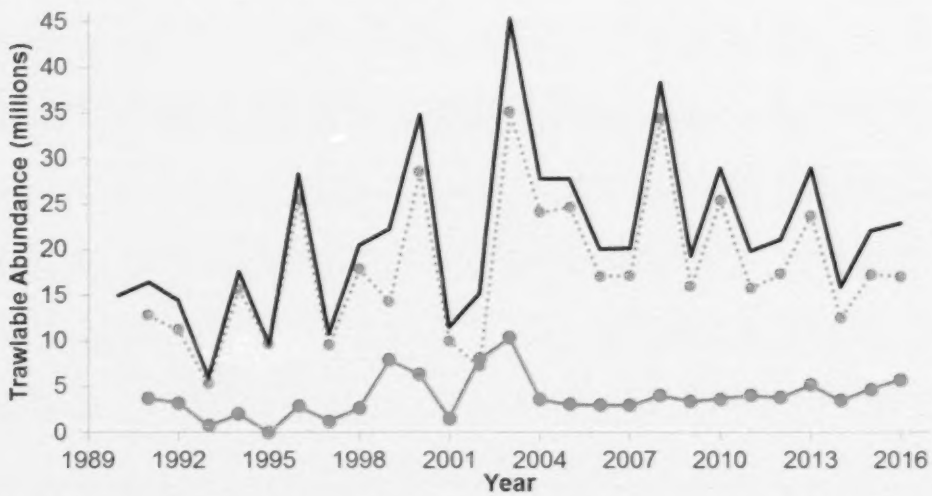


Figure 33. Abundance indices for Smooth Skate in Divs. 4RST from the DFO-Que summer research survey. The solid black line represents total abundance, while the dashed blue line represents immature (<48 cm TL) skates and the solid line with circles represents mature (≥48 cm TL) skates.*

The biomass index of Smooth Skate from the Estuary and northern Gulf (Divs. 4RST*) survey was quite variable before 2004; it has since stabilized just below the long and mid-term averages (Fig. 32). Since 2004, the index of abundance of mature Smooth Skate has increased slightly, while the opposite occurred for the immature skate (Fig. 33).

Newfoundland and Labrador Region

Updates on the status of Smooth Skate in NL waters were derived from the DFO-NL spring and fall research surveys. DFO-NL has conducted a standardized spring survey in Divs. 3LNO and Subdiv. 3Ps since 1971, a fall survey in Div. 3L since 1981, and a fall survey in Divs. 3NO since 1990. During these periods, both surveys have undergone various changes in vessel, gear type, area coverage and timing (see Simpson et al. 2011, 2012*a*,*b*, 2013). No conversion factor exists for skate; therefore, each time series is presented independently.

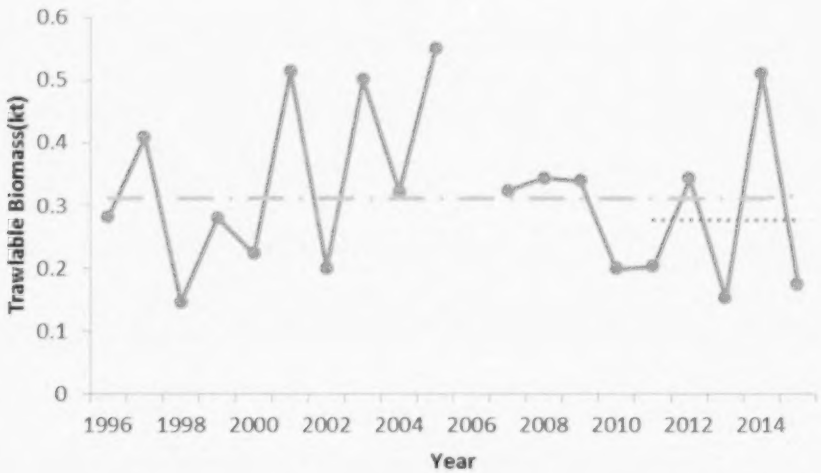


Figure 34. Biomass index for Smooth Skate in Divs. 3LNO from the DFO-NL Region spring Campelen research survey (solid line). The dashed-dot line represents the long-term survey average (1995-2015), and the dotted line represents the short-term survey average (2011-15).

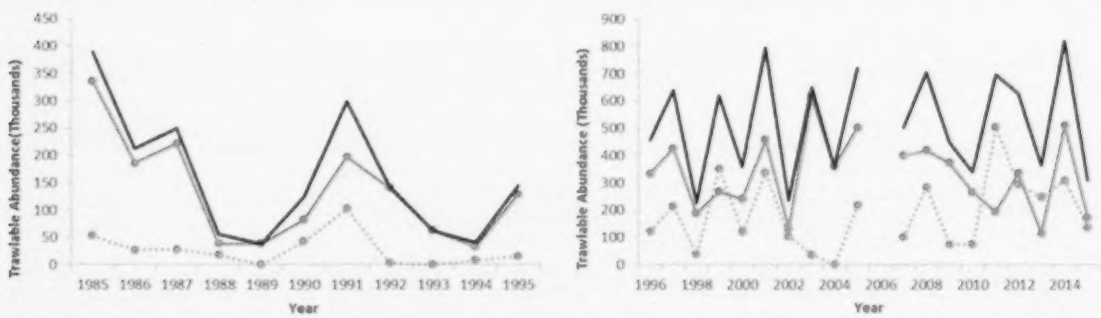


Figure 35. Abundance indices for Smooth Skate in Divs. 3LNO from the DFO-NL Region spring research survey using Engel (left panel) and Campelen (right panel) trawls. The solid black lines represent total abundance, while the dashed blue lines represent immature (<48 cm TL) skates, and the solid lines with circles represent mature (≥48 cm TL) skates.

In DFO-NL spring surveys of Divs. 3LNO, the biomass of Smooth Skate has been variable throughout the Campelen time series (1996-2015). On average, the recent biomass was slightly below the Campelen survey average (Fig. 34).

Similarly, the abundance of Smooth Skate in the DFO-NL spring surveys of Divs. 3LNO has been variable throughout the Campelen time series (1996-2015), with no overall trend (Fig. 35).

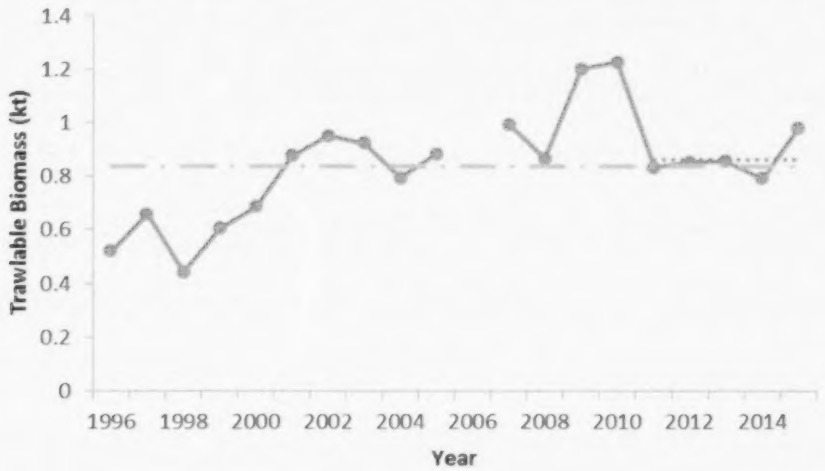


Figure 36. Biomass index for Smooth Skate in Subdiv. 3Ps from the DFO-NL Region spring Campelen research survey (solid line). The dashed-dot line represents the long-term survey average (1995-2015), and the dotted line represents the short-term survey average (2011-15).

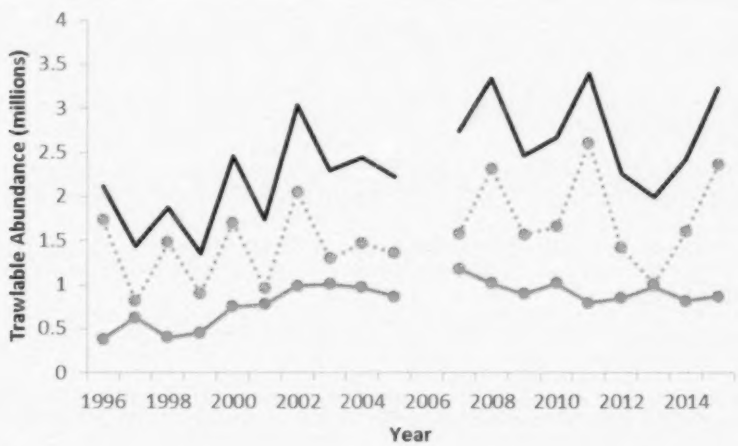


Figure 37. Abundance indices for Smooth Skate in Subdiv. 3Ps from the DFO-NL Region spring Campelen research survey. The solid black line represents total abundance, while the dashed blue line represents immature (<48 cm TL) skates, and the solid line with circles represents mature (≥48 cm TL) skates.

In the DFO-NL spring surveys of Subdiv. 3Ps, the biomass of Smooth Skate has been generally increasing from 1998 to 2010, but decreased in 2011 to stabilize at the level of the long and

short-term averages until 2015 (Fig. 36). The indices of abundance for immature and mature Smooth Skate increased from 1998 to 2005 and stabilized at a higher level from 2007 to 2015 (Fig. 37).

Central & Arctic Region

Smooth Skate is not a common species in the DFO-C&A Div. 0AB research survey; only a single immature (18 cm TL) female Smooth Skate has been captured in this survey.

Smooth Skate- Funk Island Deep DU

Newfoundland and Labrador Region

Updates on the status of Smooth Skate in the Funk Island Deep DU were derived from the DFO-NL fall research surveys. DFO-NL has conducted a standardized fall survey in Divs. 2J3KL since 1978. During these periods, the survey has undergone various changes in vessel, gear type, area coverage and timing (see Simpson et al. 2012*b*, 2013). No conversion factor exists for skate; therefore, each time series is presented independently.

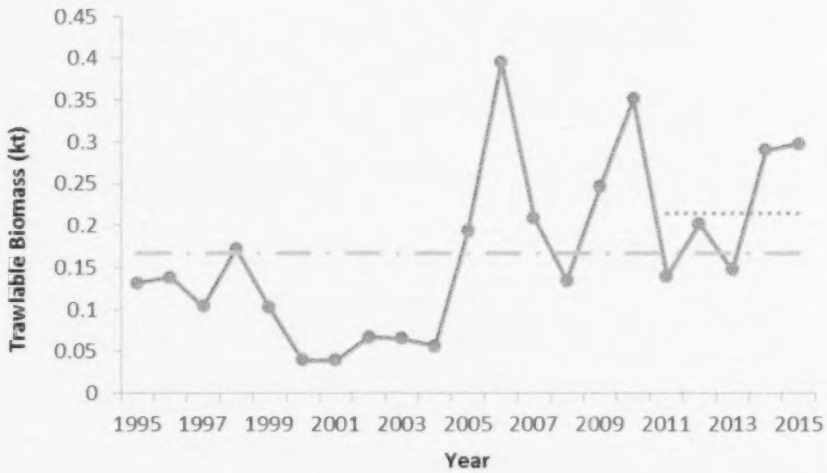


Figure 38. Biomass index for Smooth Skate in the Funk Island Deep DU from the DFO-NL Region fall Campelen research survey (solid line). The dashed-dot line represents the long-term survey average (1995-2015), and the dotted line represents the short-term survey average (2011-15).

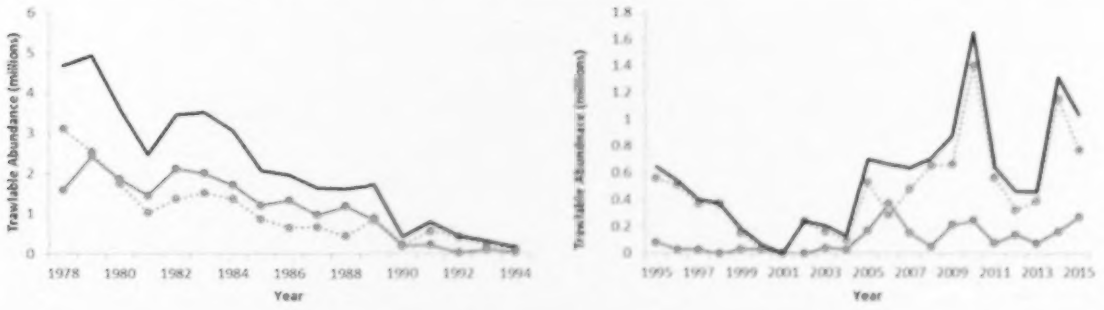


Figure 39. Abundance indices for Smooth Skate in the Funk Island Deep DU from the DFO-NL Region fall survey using Engel (left panel) and Campelen (right panel) trawls. The solid black lines represent total abundance, while the dashed blue lines represent immature (<48 cm TL) skates, and the solid lines with circles represent mature (≥48 cm TL) skates.

In the Funk Island Deep DU, recent biomass has been above the average of the Campelen survey series (1995-2015, Fig. 38). While generally variable, abundance indices, especially for adult Smooth Skate, have been increasing in recent years (Fig. 39).

Commercial Landings/Catch Data

Outside Canada's EEZ, skate landings are not reported to NAFO by species, and thus may include several species. In Atlantic Canadian waters, Kulka and Mowbray (1999) and Kulka and Miri (2007) found that 95% of commercial skate catches consisted of Thorny Skates. González-Troncoso et al. (2016) also found a similar proportion of Thorny Skate in EU-Spain research survey catches in Divs. 3NO. Therefore, skate landings in SA 2 and 3 are assumed to be 95% Thorny Skate, with the remaining 5% consisting of other skate species, such as Smooth Skate, Spinytail Skate (*Bathyraja spinicauda*), Jensen's Skate (*Amblyraja jenseni*), Barndoor Skate (*Dipturus laevis*), and Winter Skate (*Leucoraja ocellata*).

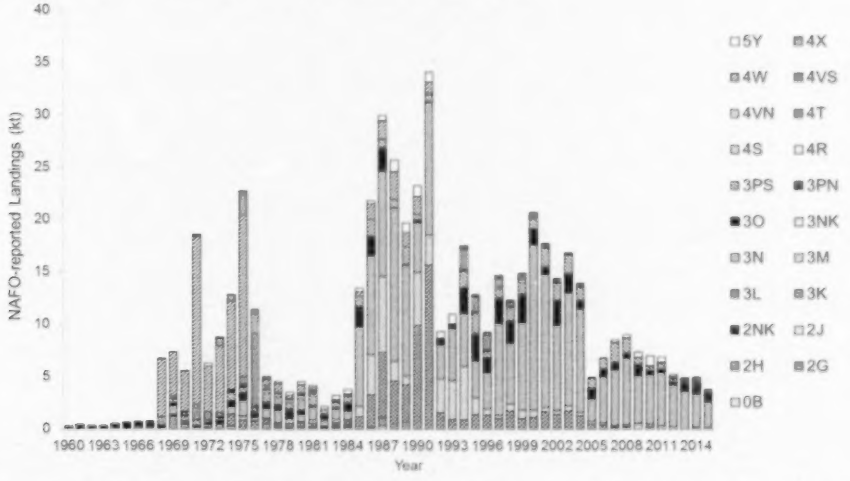


Figure 40. NAFO-reported skate landings ('000s tonnes) by Div. in SAs 0, 2, 3, 4 and Div. 5Y. Note that these landings are not identified by species, and include Thorny Skate and Smooth Skate.

Total reported skate landings, as a proxy for Thorny Skate landings, have continued to decline in recent years throughout the Atlantic and Arctic Oceans (Fig. 40). Reported landings were highest from the NAFO Regulatory Area (NRA) of Divs. 3NO due to an international skate fishery, while a Canadian skate fishery reported smaller amounts from Subdiv. 3Ps. In recent years, modest landings were also reported from Divs. 4X and 5Y. There are no skate-directed fisheries in the southern Gulf of St. Lawrence, but skate bycatch occurs in other fisheries, and most are discarded at sea. In the northern Gulf, there has been a very small skate-directed fishery, mainly in Div. 4R. On the eastern Scotian Shelf, there has also been a directed skate fishery. Overall, NAFO-reported skate landings peaked in 1991 at 34,068 t from SAs 0,2,3,4 and Div. 5Y.

There is no directed fishery for Smooth Skate in NL waters, where all Smooth Skates are discarded at sea. Annual total bycatch of this species (i.e., landings + discards at sea) in Canadian Divs. 2J3K fisheries for 2000-15 was estimated using a method based on Campana et al. (2011; see Simpson and Miri 2013 for detailed methodology) with Canadian at-sea fisheries observers' (ASO-NL) catch and discard data and DFO-NL Zonal Interchange File Format landings (ZIFF; as reported by Canadian fishers). It must be noted that Canadian at-sea observers constitute the only source of data on total catch by species, and discarding at sea. Observer coverage in most NL fisheries is extremely low (<5% annually), thereby rendering bycatch monitoring data largely inadequate. Furthermore, these bycatch estimates were dependent on the percentage of ASO coverage of each fishery in each year, as well as whether the ZIFF database contained reported landings of this species for each year of ASO coverage.

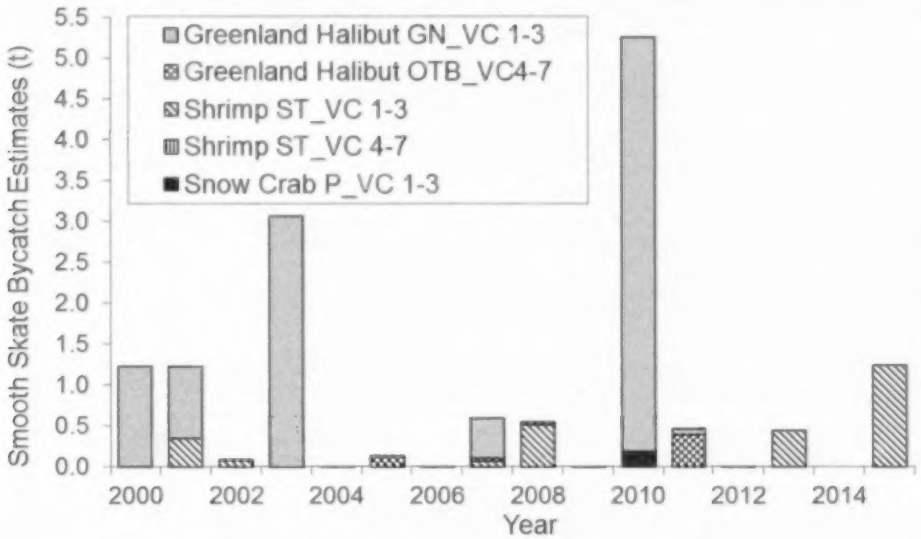


Figure 41. Bycatch estimates (kg) of Smooth Skate in observed Divs. 2J3K Canadian fisheries by gear (GN=gillnets; OTB=otter trawls, bottom; ST=shrimp trawls; P=pots), and vessel class (VC 1-3 <150 t; VC 4-7 ≥150 t), 2000-15. Data are from Canadian At-Sea Observers and DFO-NL ZIFF.

Bycatch estimates of Smooth Skate in observed Canadian 2J3K fisheries over 2000-15 suggest that commercial removals of this species in the Funk Island Deep DU are low (Fig. 41). The Greenland Halibut (Turbot; *Reinhardtius hippoglossoides*) gillnet fishery conducted by <150 t vessels caught 0-5 t (1.8 t annual average) of Smooth Skate over 2000-15. Vessels ≥150 t in the Turbot bottom otter trawl fishery caught 0-0.4 t of this species. In the Northern Shrimp

fishery, aboard ≥150 t vessels, 0-0.02 t of Smooth Skate were caught (i.e., predominantly very small juveniles that passed through the trawl's mandatory Nordmore grate or "groundfish excluder"). Smaller vessels of <150 t in the pink shrimp fishery caught 0-1.2 t (0.4 t annual average) of Smooth Skate in this time period. Bycatch of Smooth Skate appears to be negligible in the Snow Crab (*Chionoecetes opilio*) pot fishery.

In regard to post-discard mortality, Benoît (2006) found short-term mortality rate of at least 50% from bottom otter trawls (DFO 2005 research survey fishing 0.5-hour sets), Thorny Skate appeared to have a slightly lower mortality rate than Smooth Skate. It was also noted that commercial groundfish trawl fisheries, which fish gear for 1-4 hours, should result in even higher skate post-discard mortality rates. In addition, anecdotal evidence (NL-ASOs, pers. comm.) indicated 100% discard mortality for skates caught in gillnets (due to drowning over a few days before gear retrieval), and nearly 100% mortality is assumed for groundfish longlines (due to severe jaw damage caused by removal from the fish hooks).

Conclusions

Thorny Skate

- Indices from the Divs. 4VWX DFO summer survey, and the DFO winter Georges Bank survey indicate that Thorny Skate remain at very low levels, with no real indication of recovery.
- Indices of Thorny Skate from the southern Gulf (Div. 4T) DFO survey remain at very low levels, with no real indication of recovery.
- Indices of Thorny Skate from the Estuary and northern Gulf (Divs. 4RST*) DFO survey have been generally stable since 2004 at a level slightly higher than for the 1992-2002 period.
- Indices of Thorny Skate from the fall DFO survey in Divs. 2J3KLNO have been generally increasing since 1995, indicating improvement in the overall stock status.
- Indices of Thorny Skate from the spring DFO survey in Divs. 3LNO and Subdiv. 3Ps have been generally increasing since 1996, indicating improvement in the overall stock status.
- Indices from the SA 0 fall survey indicate that Thorny Skate have been generally stable since 2000.
- Overall, Thorny Skate in the Atlantic and Arctic Oceans, while showing improvement in northern waters, remain at very low levels in southern areas of its distribution.

Smooth Skate – Laurentian-Scotian population

- Indices from the Divs. 4VWX DFO summer survey, and the DFO winter Georges Bank survey, indicate that Smooth Skate remain at low levels, however there has been very little change in abundance in recent years.
- Indices of Smooth Skate abundance from the southern Gulf (Div. 4T) DFO survey have tended to be high for immature skates over the past decade relative to the levels between the mid-1970s and early-1980s. For adults, abundance indices have increased to an intermediate level since the mid-2000s.
- Indices of Smooth Skate from the Estuary and northern Gulf (Divs. 4RST*) DFO survey have been generally stable since 2004.

- Indices of Smooth Skate from the spring DFO survey in Divs. 3LNO and Subdiv. 3Ps have varied without trend since 1996, indicating little change in the overall stock status.
- Overall adult indices have been stable and juvenile indices have been increasing or stable since the 1990s. However, adult abundance remains very low in Divs. 4VW where declines were the greatest.

Smooth Skate – Funk Island Deep population

- Indices of Smooth Skate from the fall DFO survey in Funk Island Deep DU have, in recent years, been above the average since 1995, indicating some improvement in the overall stock status.

Commercial landings

- Although reported commercial landings of skates within Canada's EEZ have generally declined in recent years, the ongoing very low at-sea observer coverage (0-5% annually) of most Atlantic Canadian groundfish fisheries precludes reliable estimates of total skate catch.
- Post-discard mortality of skate is assumed to be very high for both species, with an acute mortality rate of at least 50% from bottom otter trawls, nearly 100% from groundfish longlines, and 100% from gillnets.

Contributors

- Mark Simpson (Lead), DFO-Science, Newfoundland and Labrador Region
- Don Clark, DFO-Science, Maritimes Region
- Johanne Gauthier, DFO-Science, Quebec Region
- Kevin Hedges, DFO-Science, Central and Arctic Region
- Doug Swain, DFO-Science, Gulf Region
- Roanne Collins, DFO Science, Newfoundland and Labrador Region
- Carolyn Miri, DFO-Science, Newfoundland and Labrador Region
- James Meade, DFO-CSAS, Newfoundland and Labrador Region
- Erika Parrill, DFO-CSAS, Newfoundland and Labrador Region

Approved by

B. R. McCallum
Regional Director Science
Newfoundland and Labrador Region
Fisheries and Oceans Canada

Date: January 13, 2017

Sources of information

Benoît, H.P. 2006. Estimated discards of winter skate (*Leucoraja ocellata*) in the southern Gulf of St. Lawrence, 1971-2004. DFO Can. Sci. Advis. Sec. Res. Doc.2006/002.

Bourdages, H., L. Savard, D. Archambault and S. Valois. 2007. Results from the August 2004 and 2005 comparative fishing experiments in the northern Gulf of St. Lawrence between the CCGS *Alfred Needler* and the CCGS *Teleost*. Can. Tech. Rep. Fish. Aquat. Sci. 2750: ix + 57 p.

Bourdages, H., Brassard, C., Desgagnés, M., Galbraith, P., Gauthier, J., Légaré, B., Nozères, C., Parent, E., and Schwab, P. 2016. Preliminary results from the groundfish and shrimp multidisciplinary survey in August 2015 in the Estuary and northern Gulf of St. Lawrence. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/004. v + 87 p.

Campana, S.E., Brading, J., and Joyce, W. 2011. Estimation of pelagic shark bycatch and associated mortality in Canadian Atlantic Fisheries. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/067. vi +19 p.

DFO. 2016*a*. 2015 Maritimes Research Vessel Survey Trends on the Scotian Shelf and Bay of Fundy. DFO Can. Sci. Advis. Sec. Sci. Resp. 2016/011.

DFO. 2016*b*. 2016 Maritimes Winter Research Vessel Survey Trends on Georges Bank. DFO Can. Sci. Advis. Sec. Sci. Resp. 2016/042.

González-Troncoso, D., Gago, A., and Nogueira, A. 2016. Biomass and length distribution for roughhead grenadier, thorny skate and white hake from the surveys conducted by Spain in NAFO 3NO. NAFO Sci. Coun. Res. Doc. 16/012, Ser. No. N6548. 30p.

Kulka, D.W., and Miri, C.M. 2007. Update on the status of Thorny Skate (*Amblyraja radiata* Donovan, 1808). *In* Case studies in the Management of Elasmobranch Fisheries. Edited by R. Shotton. FAO Fish. Tech. Pap. 378/1: 47-73.

Kulka, D.W., and Mowbray, F.K. 1999. An overview of the Grand Banks skate fishery. *In* Case studies in the Management of Elasmobranch Fisheries. Edited by R. Shotton. FAO Fish. Tech. Pap. 378/1: 47-73.

Simon, J.E., Rowe, S., and Cook, A. 2012. Status of Smooth Skate (*Malacoraja senta*) and Thorny Skate (*Amblyraja radiata*) in the Maritimes Region. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/080: viii + 102 p.

Simpson, M.R., and Miri, C.M. 2013. A pre-COSEWIC assessment of Porbeagle Shark (*Lamna nasus*) in Newfoundland and Labrador waters. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/088. iv + 19 p.

Simpson, M.R., Mello, L.G.S., Miri, C., Treble, M.M., and Siferd, T. 2011. A pre-COSEWIC assessment of Thorny Skate (*Amblyraja radiata* Donovan, 1808) on the Grand Bank, Newfoundland Shelf, Labrador and northern waters. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/084. iv + 56 p.

Simpson, M.R., Miri, C.M., and Mello, L.G.S. 2012*a*. An assessment of Thorny Skate (*Amblyraja radiata* Donovan, 1808) in NAFO Subdivision 3Ps and Divisions 3LNO. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/139. iv + 38 p.

Simpson, M.R., Mello, L.G.S., Miri, C.M., Treble, M., and Siferd, T. 2012*b*. Distribution, abundance, and life history of smooth skate (*Malacoraja senta* Garman 1885) in Northwest Atlantic waters. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/116. iv + 40 p.

Simpson, M.R., Miri, C.M., Mello, L.G.S., Collins, R.K., and Bailey, J.A. 2013. Assessment of the Potential for Recovery of Smooth Skate (*Malacoraja senta* Garman 1885) in the Funk Island Deep Designatable Unit. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/098. iv + 22 p.

Swain, D.P., Benoît, H.P., Daigle, D., and Aubry, É. 2012*a*. Thorny skate (*Amblyraja radiata*) in the southern Gulf of St. Lawrence: life history, and trends from 1971 to 2010 in abundance, distribution and potential threats. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/032. iii + 42 p.

Swain, D.P., Benoît, H.P., and Aubry, É. 2012*b*. Smooth skate (*Malacoraja senta*) in the southern Gulf of St. Lawrence: life history, and trends from 1971-2010 in abundance, distribution and potential threats. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/033. iii + 34 p.

Treble, M. 2013. Report on Greenland halibut caught during the 2012 trawl survey in NAFO Division 0A. NAFO Sci. Coun. Res. Doc. 13/033, Ser. No. N6187. 31p.

Treble, M. 2016. Report on Greenland halibut caught during the 2015 trawl survey in Divisions 0A and 0B. NAFO Sci. Coun. Res. Doc. 16/025, Ser. No. N6568. 33p.

This Report is Available from the

Center for Science Advice (CSA)
Newfoundland and Labrador Region
Fisheries and Oceans Canada
PO Box 5667
St. John's, NL A1C 5X1

Telephone: (709) 772-3332
E-Mail: DFONLCentreforScienceAdvice@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas-sccs/

ISSN 1919-3769
© Her Majesty the Queen in Right of Canada, 2017

Correct Citation for this Publication:

DFO. 2017. Status Updates for Thorny Skate in the Canadian Atlantic and Arctic Oceans and Smooth Skate (Laurentian-Scotian and Funk Island Deep Designatable Units). DFO Can. Sci. Advis. Sec. Sci. Resp. 2017/011.

Aussi disponible en français :

MPO. 2017. Mises à jour sur la situation de la raie épineuse dans les eaux canadiennes des Océans Atlantique et Arctique et de la raie à queue de velours (unités désignables du chenal Laurentien et du plateau néo-écossais ainsi que de la fosse de l'île Funk). Secr. can. de consult. sci. du MPO, Rép. des Sci. 2017/011.